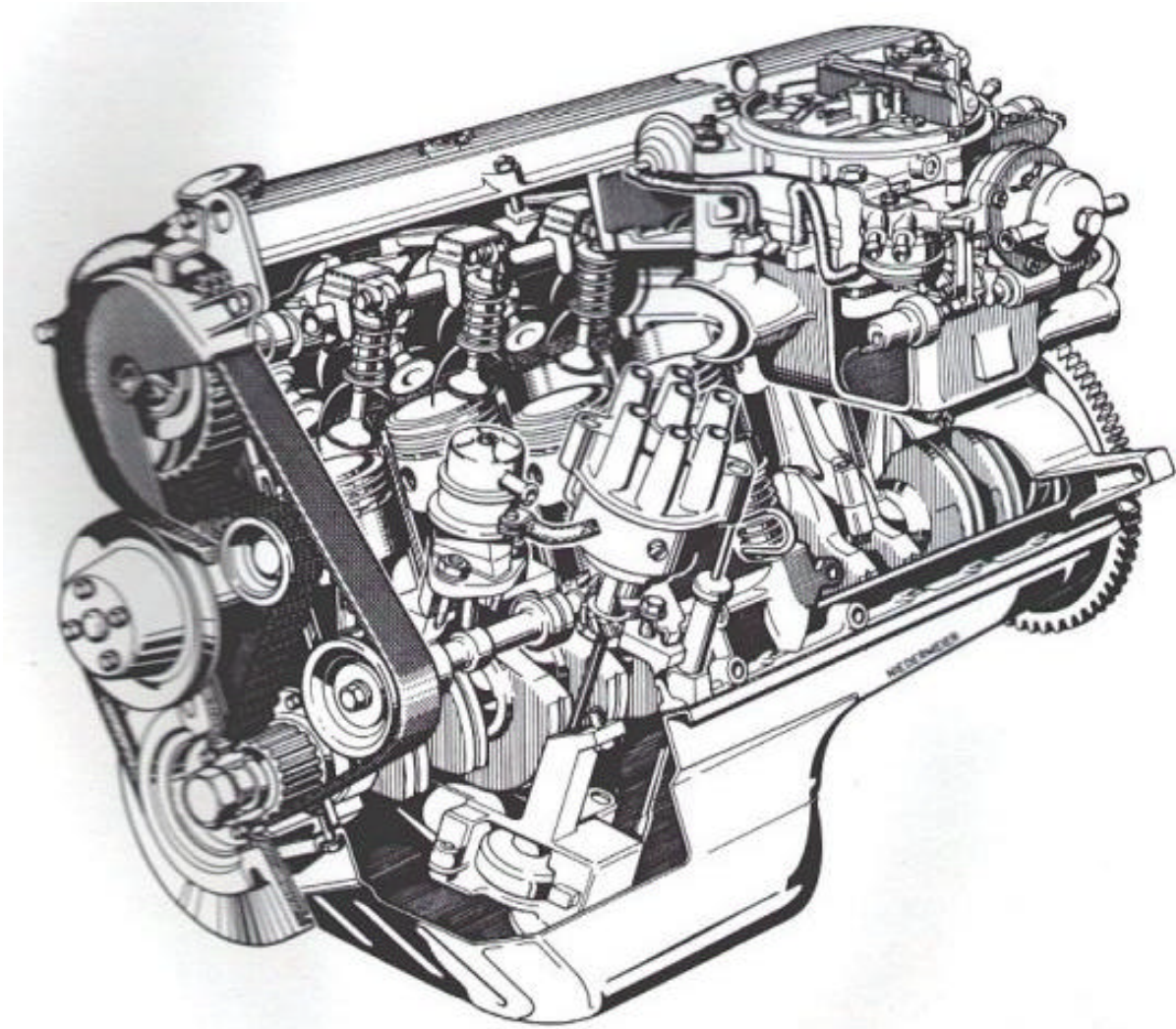


# E21 M20 Displacement Whitepaper



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## **Goals**

The idea is to increase the displacement of the BMW 320/6 M20 engine while still keeping the original block, head and fuel system (carb), to get more torque in low-rpm ranges, as well as a little more power in higher rpm ranges.

The reason I have to stay with stock as much as possible is because the law prevents me from changing anything to the engine, so if I increase the displacement I have to make sure it cannot be seen by inspecting my engine bay.

The goal is definitely not a performance or track car, but a comfortable daily driver.

## **320/6 stock specs**

- Bore : 80.0mm
- Stroke : 66.0mm
- Displacement 1990cm<sup>3</sup>
- Combustion Chamber volume 40.4cm<sup>3</sup>
- Power output : 122HP
- Torque 160Nm

## **Problem analysis**

It is impossible to increase the bore diameter in the 320/6 or 323i block because the cylinder walls are too close to waterways. The 325i and "ETA" blocks are different, that is why they have a 84.0mm bore and still have room for safe 86.0mm bores.

I guess you could bore your block an extra millimeter or two, but then you would have to get custom pistons made, and the slight displacement increase does not justify the cost.

If you want more performance, you should look into the 2.7L conversions using an ETA block and crank.

Keeping the bore means the same piston set can remain in use if shorter rods and a different crank are fitted. If the pistons are still in good shape (like mine) then you should be able to reuse them.

However, installing a crank with larger stroke means that the pistons would stick out of the block at TDC, so you will need to make modifications. Stock 323i pistons can be used right away for the 323/6 conversion, but custom pistons will be required for a 2.4L stroker.

## **Advantage analysis**

- **Pro**
  - o More low-end torque
  - o A little more HP
  - o Fairly easy to accomplish
  - o Higher compression (ok if 98 octane fuel is used)
- **Contra**
  - o Lower redline (5500rpm to be safe)
  - o More torque and power on the clutch
  - o Longer stroke means faster bore and piston wear, sometimes even piston ovalising. However, I trust the engine would run at least 100,000km before suffering from wear.

Again, we're looking to build a comfortable daily driver, so improvements at low rpm are more valuable than close-to-redline performance. The fuel quality is a lot worse in the US than in Europe, but judging from the experience of US owners 91 oct fuel should do as well.

### ***Crankshaft options:***

- **320/6 crankshaft**
  - o Stroke 66.0mm
  - o Yields 1990cm<sup>3</sup>
  - o Output power 122HP
  - o Output torque 160Nm
- **323i crankshaft**
  - o Stroke 76.8mm
  - o Yields 2316cm<sup>3</sup>
  - o Use stock 323i pistons
  - o Projected HP (interpolated) 142HP
  - o Projected torque (interpolated) 189Nm
  - o Projected compression ratio 10.5:1
- **324d crankshaft**
  - o Stroke 81.0mm
  - o Yields 2443cm<sup>3</sup>
  - o Requires custom pistons, or 323i pistons can be used if you shave them 2.1mm
  - o Projected HP (interpolated) 151HP
  - o Projected torque (interpolated) 200Nm
  - o Projected compression ratio 11.0:1

### ***Some facts***

In order to increase displacement there are two crankshafts available that will bolt right on.

The first one is the 323i crankshaft, which can be used with the 323i rods and pistons in the 320/6 block, resulting in a 323/6 without requiring any other modification.

More interesting would be the 324d or 524td crankshaft, which is forged and not cast like the other cranks. A forged crank is a lot stronger and will withstand high rpms better, although a cast crank is definitely not weak either. You will want to use a diesel crank for turbocharged engines though. The forged 324d crank has its counterpart in the 325e or 528e crankshaft, which is also an 81.0mm stroker and identical to the 324d crank except it was cast not forged. Either one will do for the 2.4L conversion.

However, the 2.4L stroker requires custom pistons. Either have them custom-made, or get your hands on a set of 323i pistons and shave them exactly 2.1mm. This will bring them right at the block surface at TDC.

The Solex/Pierburg carburettor used on the 320/6 will easily serve the engine up to 180HP. It was used on early 3.0L M30 engines as well, so it can provide the extra power by a large margin if you stroke the engine to either 2.3L or 2.4L.

### ***Conclusion***

You should see a moderate increase of horsepower as stated above, and fair increase of torque at relatively low rpms. If you have fitted a diesel crank, you don't have to worry about breaking it, so you can rev easily to 6,400rpm, and the same goes for a 323i crank and pistons. Though the ETA crank is strong, it has been known to break under very heavy circumstances, so it is OK to use it unless you're building a power beast. But that wasn't the purpose of this paper in the first place ☺.